

Claims

What is claimed is:

1. An apparatus for coupling a tubular member to a preexisting structure, comprising:
 - a first support member including a first fluid passage;
 - a manifold coupled to the support member including:
 - a second fluid passage coupled to the first fluid passage including a throat passage adapted to receive a plug;
 - a third fluid passage coupled to the second fluid passage; and
 - a fourth fluid passage coupled to the second fluid passage;
 - a second support member coupled to the manifold including a fifth fluid passage coupled to the second fluid passage;
 - an expansion cone coupled to the second support member;
 - a tubular member coupled to the first support member including one or more sealing members positioned on an exterior surface;
 - a first interior chamber defined by the portion of the tubular member above the manifold, the first interior chamber coupled to the fourth fluid passage;
 - a second interior chamber defined by the portion of the tubular member between the manifold and the expansion cone, the second interior chamber coupled to the third fluid passage;
 - a third interior chamber defined by the portion of the tubular member below the expansion cone, the third interior chamber coupled to the fifth fluid passage; and
 - a shoe coupled to the tubular member including:
 - a throat passage coupled to the third interior chamber adapted to receive a wiper dart; and
 - a sixth fluid passage coupled to the throat passage.

2. A method of coupling a tubular member to a preexisting structure, comprising:

positioning a support member, an expansion cone, and a tubular member within a preexisting structure;
injecting a first quantity of a fluidic material into the preexisting structure below the expansion cone; and
injecting a second quantity of a fluidic material into the preexisting structure above the expansion cone.

3. An apparatus, comprising:
a preexisting structure; and
an expanded tubular member coupled to the preexisting structure;
wherein the expanded tubular member is coupled to the preexisting structure by a process comprising:
positioning a tubular support member defining an internal longitudinal passage, an expansion cone, and the tubular member within the preexisting structure;
injecting a first fluidic material through the internal passage of the tubular support member into the preexisting structure below the expansion cone; and
injecting a second fluidic material through the internal passage of the tubular support member into the preexisting structure above the expansion cone.
4. An apparatus for coupling two elements, comprising:
a support member including one or more support member slots;
a tubular member including one or more tubular member slots; and
a coupling for removably coupling the tubular member to the support member, including:
a coupling body movably coupled to the support member;
one or more coupling arms extending from the coupling body; and

coupling elements extending from corresponding coupling arms adapted to mate with corresponding support member and tubular member slots.

5. A method of coupling a first member to a second member, comprising:
forming a first set of coupling slots in the first member;
forming a second set of coupling slots in the second member;
aligning the first and second pairs of coupling slots; and
inserting coupling elements into each of the pairs of coupling slots.
6. An apparatus for controlling the flow of fluidic materials within a housing, comprising:
a first passage within the housing;
a throat passage within the housing fluidically coupled to the first passage adapted to receive a plug;
a second passage within the housing fluidically coupled to the throat passage;
a third passage within the housing fluidically coupled to the first passage;
one or more valve chambers within the housing fluidically coupled to the third passage including moveable valve elements;
a fourth passage within the housing fluidically coupled to the valve chambers and a region outside of the housing;
a fifth passage within the housing fluidically coupled to the second passage and controllably coupled to the valve chambers by corresponding valve elements; and
a sixth passage within the housing fluidically coupled to the second passage and the valve chambers.
7. A method of controlling the flow of fluidic materials within a housing including an inlet passage and an outlet passage, comprising:
injecting fluidic materials into the inlet passage;

blocking the inlet passage; and
opening the outlet passage.

8. An apparatus, comprising:
 - a first tubular member;
 - a second tubular member positioned within and coupled to the first tubular member;
 - a first annular chamber defined by the space between the first and second tubular members;
 - an annular piston movably coupled to the second tubular member and positioned within the first annular chamber;
 - an annular sleeve coupled to the annular piston and positioned within the first annular chamber;
 - a third annular member coupled to the second annular member and positioned within and movably coupled to the annular sleeve;
 - a second annular chamber defined by the space between the annular piston, the third annular member, the second tubular member, and the annular sleeve;
 - an inlet passage fluidically coupled to the first annular chamber; and
 - an outlet passage fluidically coupled to the second annular chamber.
9. A method of applying an axial force to a first piston positioned within a first piston chamber, comprising:
 - applying an axial force to the first piston using a second piston positioned within the first piston chamber.
10. An apparatus for radially expanding a tubular member, comprising:
 - a support member;
 - a tubular member coupled to the support member;

a mandrel movably coupled to the support member and positioned within the tubular member;

an annular expansion cone coupled to the mandrel and movably coupled to the tubular member for radially expanding the tubular member; and

a lubrication assembly coupled to the mandrel for supplying a lubricant to the annular expansion cone, including:

- a sealing member coupled to the annular member;
- a body of lubricant positioned in an annular chamber defined by the space between the sealing member, the annular member, and the tubular member; and
- a lubrication supply passage fluidically coupled to the body of lubricant and the annular expansion cone for supplying a lubricant to the annular expansion cone.

11. A method of operating an apparatus for radially expanding a tubular member including an expansion cone, comprising:
- lubricating the interface between the expansion cone and the tubular member;
 - centrally positioning the expansion cone within the tubular member; and
 - applying a substantially constant axial force to the tubular member prior to a beginning of a radial expansion process.
12. An apparatus, comprising:
- a support member;
 - a tubular member coupled to the support member;
 - an annular expansion cone movably coupled to the support member and the tubular member and positioned within the tubular member for radially expanding the tubular member; and
 - a preload assembly for applying an axial force to the annular expansion cone, including:

a compressed spring coupled to the support member for applying the axial force to the annular expansion cone; and
a spacer coupled to the support member for controlling the amount of spring compression.

13. An apparatus for coupling a tubular member to a preexisting structure, comprising:

- a support member;
- a manifold coupled to the support member for controlling the flow of fluidic materials within the apparatus;
- a radial expansion assembly movably coupled to the support member for radially expanding the tubular member; and
- a coupling assembly for removably coupling the tubular member to the support member.

14. An apparatus for coupling a tubular member to a preexisting structure, comprising:

- an annular support member including a first passage;
- a manifold coupled to the annular support member, including:
 - a throat passage fluidically coupled to the first passage adapted to receive a fluid plug;
 - a second passage fluidically coupled to the throat passage;
 - a third passage fluidically coupled to the first passage;
 - a fourth passage fluidically coupled to the third passage;
 - one or more valve chambers fluidically coupled to the fourth passage including corresponding movable valve elements;
 - one or more fifth passages fluidically coupled to the second passage and controllably coupled to corresponding valve chambers by corresponding movable valve elements;

- one or more sixth passages fluidically coupled to a region outside of the manifold and to corresponding valve chambers;
- one or more seventh passages fluidically coupled to corresponding valve chambers and the second passage; and
- one or more force multiplier supply passages fluidically coupled to the fourth passage;
- a force multiplier assembly coupled to the annular support member, including:
 - a force multiplier tubular member coupled to the manifold;
 - an annular force multiplier piston chamber defined by the space between the annular support member and the force multiplier tubular member and fluidically coupled to the force multiplier supply passages;
 - an annular force multiplier piston positioned in the annular force multiplier piston chamber and movably coupled to the annular support member;
 - a force multiplier sleeve coupled to the annular force multiplier piston;
 - a force multiplier sleeve sealing member coupled to the annular support member and movably coupled to the force multiplier sleeve for sealing the interface between the force multiplier sleeve and the annular support member;
 - an annular force multiplier exhaust chamber defined by the space between the annular force multiplier piston, the force multiplier sleeve, and the force multiplier sleeve sealing member; and
 - a force multiplier exhaust passage fluidically coupled to the annular force multiplier exhaust chamber and the interior of the annular support member;
- an expandable tubular member;
- a radial expansion assembly movably coupled to the annular support member, including:

an annular mandrel positioned within the annular force multiplier piston chamber;

an annular expansion cone coupled to the annular mandrel and movably coupled to the expandable tubular member;

a lubrication assembly coupled to the annular mandrel for supplying lubrication to the interface between the annular expansion cone and the expandable tubular member;

a centralizer coupled to the annular mandrel for centering the annular expansion cone within the expandable tubular member; and

a preload assembly movably coupled to the annular support member for applying an axial force to the annular mandrel; and

a coupling assembly coupled to the annular support member and releasably coupled to the expandable tubular member, including:

a tubular coupling member coupled to the expandable tubular member including one or more tubular coupling member slots;

an annular support member coupling interface coupled to the annular support member including one or more annular support member coupling interface slots; and

a coupling device for releasably coupling the tubular coupling member to the annular support member coupling interface, including:

a coupling device body movably coupled to the annular support member;

one or more resilient coupling device arms extending from the coupling device body; and

one or more coupling device coupling elements extending from corresponding coupling device arms adapted to removably mate with corresponding tubular coupling member and annular support member coupling slots.

15. A method of coupling a tubular member to a pre-existing structure, comprising:

positioning an expansion cone and the tubular member within the preexisting structure using a support member;
displacing the expansion cone relative to the tubular member in the axial direction; and
decoupling the support member from the tubular member.

16. An apparatus, comprising:
a preexisting structure; and
a radially expanded tubular member coupled to the preexisting structure by a process comprising:
positioning an expansion cone and the tubular member within the preexisting structure using a support member;
displacing the expansion cone relative to the tubular member in the axial direction; and
decoupling the support member from the tubular member.
17. The method of claim 9, wherein the first and second pistons have annular cross sections.
18. The method of claim 9, further comprising:
movably coupling the first and second pistons to a tubular support member defining an internal passage.
19. The method of claim 18, further comprising:
displacing the second piston; and
exhausting fluidic materials displaced by the second piston into the internal passage of the tubular support member.
20. The method of claim 19, wherein exhausting fluidic materials displaced by the second piston into the internal passage of the tubular support member comprises:

exhausting fluidic materials within an exhaust chamber defined between the second piston and the tubular support member displaced by the second piston into the internal passage of the tubular support member.

21. The method of claim 20, wherein the first piston chamber and the exhaust chamber have annular cross sections.
22. The method of claim 20, wherein the cross sectional area of the first piston chamber is greater than the cross sectional area of the exhaust chamber.
23. The method of claim 20, wherein the operating pressure of the exhaust chamber is less than a portion of the first piston chamber downstream from the first piston.
24. The method of claim 20, wherein the exhaust chamber is fluidically isolated from the first piston chamber.
25. The method of claim 9, further comprising:
applying an axial force to the first piston by direct application of fluidic materials.
26. The method of claim 9, wherein a portion of the first piston chamber upstream from the first piston has a larger cross sectional area than a portion of the first piston chamber downstream from the first piston.
27. The method of claim 26, wherein the first piston chamber has an annular cross section.
28. The method of claim 9, wherein:
the cross sectional area of the first piston is greater than the cross sectional area of the second piston.

29. The method of claim 9, further comprising:
injecting fluidic materials into the first piston chamber.
30. The method of claim 9, wherein the first piston comprises an expansion cone for radially expanding and plastically deforming a tubular member.
31. The method of claim 30, wherein the expansion cone includes one or more outer conical surfaces for engaging the tubular member.
32. The method of claim 9, further comprising:
applying an axial force to the first piston by direct application of fluidic materials;
wherein a portion of the first piston chamber upstream from the first piston has a
larger cross sectional area than a portion of the first piston chamber
downstream from the first piston; and
wherein the first piston chamber has an annular cross section.
33. The method of claim 9, further comprising:
movably coupling the first and second pistons to a tubular support member
defining an internal passage;
displacing the second piston; and
exhausting fluidic materials within an exhaust chamber defined between the
second piston and the tubular support member displaced by the second
piston into the internal passage of the tubular support member;
wherein the first piston chamber and the exhaust chamber have annular cross
sections;
wherein the cross sectional area of the first piston chamber is greater than the
cross sectional area of the exhaust chamber;
wherein the operating pressure of the exhaust chamber is less than a portion of
the first piston chamber downstream from the first piston; and
wherein the exhaust chamber is fluidically isolated from the first piston chamber.

34. The method of claim 9, further comprising:
injecting fluidic materials into the first piston chamber;
wherein the cross sectional area of the first piston is greater than the cross sectional area of the second piston; and
wherein the first piston comprises an expansion cone including one or more outer conical surfaces for radially expanding and plastically deforming a tubular member.
35. A method of displacing an annular expansion cone for radially expanding an expandable tubular member, comprising:
movably coupling the annular expansion cone to a first tubular support member defining an internal passage;
positioning the annular expansion cone within a first annular chamber defined between the expandable tubular member and the first tubular support member;
positioning an annular piston within a second annular chamber defined between the first tubular support member and a second tubular support member;
defining a third annular chamber between the annular piston and the first tubular support member that is fluidically coupled to the internal passage of the first tubular support member;
injecting fluidic materials into the second annular chamber to displace the annular piston within the second annular chamber;
exhausting fluidic materials displaced by the annular piston out of the third annular chamber into the internal passage of the first tubular support member; and
the annular piston impacting and displacing the annular expansion cone relative to the first tubular support member;
wherein the cross sectional area of the second annular chamber is greater than the cross sectional area of the third annular chamber;

wherein the first and second annular chambers are fluidically isolated from the third annular chamber; and

wherein a cross sectional area of a region of the first annular chamber upstream from the annular expansion cone is greater than a cross sectional area of a region of the first annular chamber downstream from the annular expansion cone.